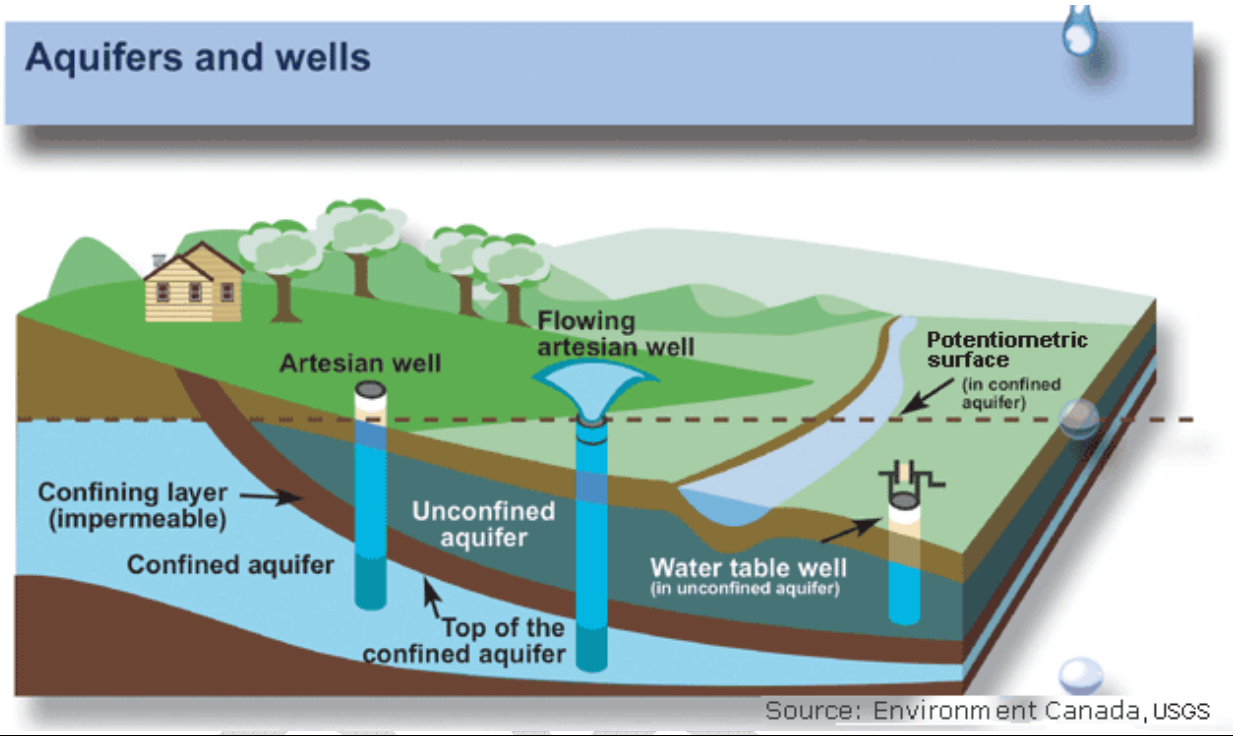
TRIDENT AREA GROUNDWATER MANAGEMENT PLAN



Trident Area Groundwater Management Plan

Executive Summary

South Carolina's Groundwater Use and Reporting Act (Chapter 5, Section 49-5-60) gives the South Carolina Department of Health and Environmental Control (DHEC) the legal authority and mandate to establish and implement a local groundwater management program in designated Capacity Use Areas. Effective groundwater management ensures that the groundwater resources of the State are put to beneficial use to the fullest extent which they are capable, conserves and protects the resource, prevents waste, and establishes conditions which are conducive to the development and long-term viability of the water resources. As aquifers and the relative social and economic requirements of the State vary by area and region, groundwater management should be locally and/or regionally assessed, balancing all needs and interests. In this regard, DHEC will coordinate with affected governing bodies and groundwater withdrawers to achieve stated goals, effect sustainable development of the groundwater resources, and ensure development of compatible groundwater management plans. Sustainable development is the key guiding principle, where South Carolina's groundwater resources are managed so that development meets the needs of the present without compromising the ability of future generations to meet their needs.

Introduction

On August 8, 2002, the South Carolina Department of Health and Environmental Control Board, as established in Section 49-5-60, Capacity Use Designation, declared the whole of Berkeley County, Charleston County, and Dorchester County as the ***Trident Capacity Use Area*** (Trident Area), Figure 1. The Trident Area was the third of the four currently declared Capacity Use Areas in South Carolina. Within the Trident Area, no person shall withdraw, obtain, or otherwise utilize groundwater at or in excess of three (3) million gallons per month for any purpose unless said person shall first obtain a Groundwater Withdrawal Permit from DHEC. A groundwater withdrawer is defined as any person withdrawing groundwater at or in excess of three (3) million gallons during any one month from a *single well* or *multiple wells* within a one-mile radius of any existing or proposed well.

The Board of the Berkeley-Charleston-Dorchester Council of Governments (BCDCOG) concurred with the designation of the Berkeley-Charleston-Dorchester (BCD) Region as a Capacity Use Area and the role of the BCDCOG as lead for the development of the Trident Area Groundwater Management Plan. The plan will guide the initial groundwater management strategy and provide direction for future groundwater management goals by evaluating, as data become available, the hydrologic, environmental, social, and economic impacts of groundwater withdrawals at various rates on the long-term sustainable levels for the aquifers of the Trident Area. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their needs and requirements. Therefore, the three general goals of the Trident Area Groundwater Management Plan are:

1. Ensure sustainable development of the groundwater resource by management of groundwater withdrawals;
2. The protection of groundwater quality from salt-water intrusion; and,
3. Monitoring of groundwater quality and quantity to evaluate conditions.

To accomplish the above goals, the Trident Area Groundwater Management Plan will address the following aspects of water use in the BCD region:

- Groundwater sources currently utilized;
- Current water demand by type and amount used;
- Current aquifer storage and recovery and water reuse;
- Population and growth projections;
- Water demand projections;
- Projected opportunities for aquifer storage and recovery, as well as water reuse;
- Projected groundwater and surface water options; and,
- Water conservation measures.

Planning is a multi-stage process that includes provisions for updating/amending as conditions change over time. In this first plan, only general goals can be established. As more data are developed about the groundwater resources of the Trident Area, more specific goals and withdrawal limits can be incorporated.

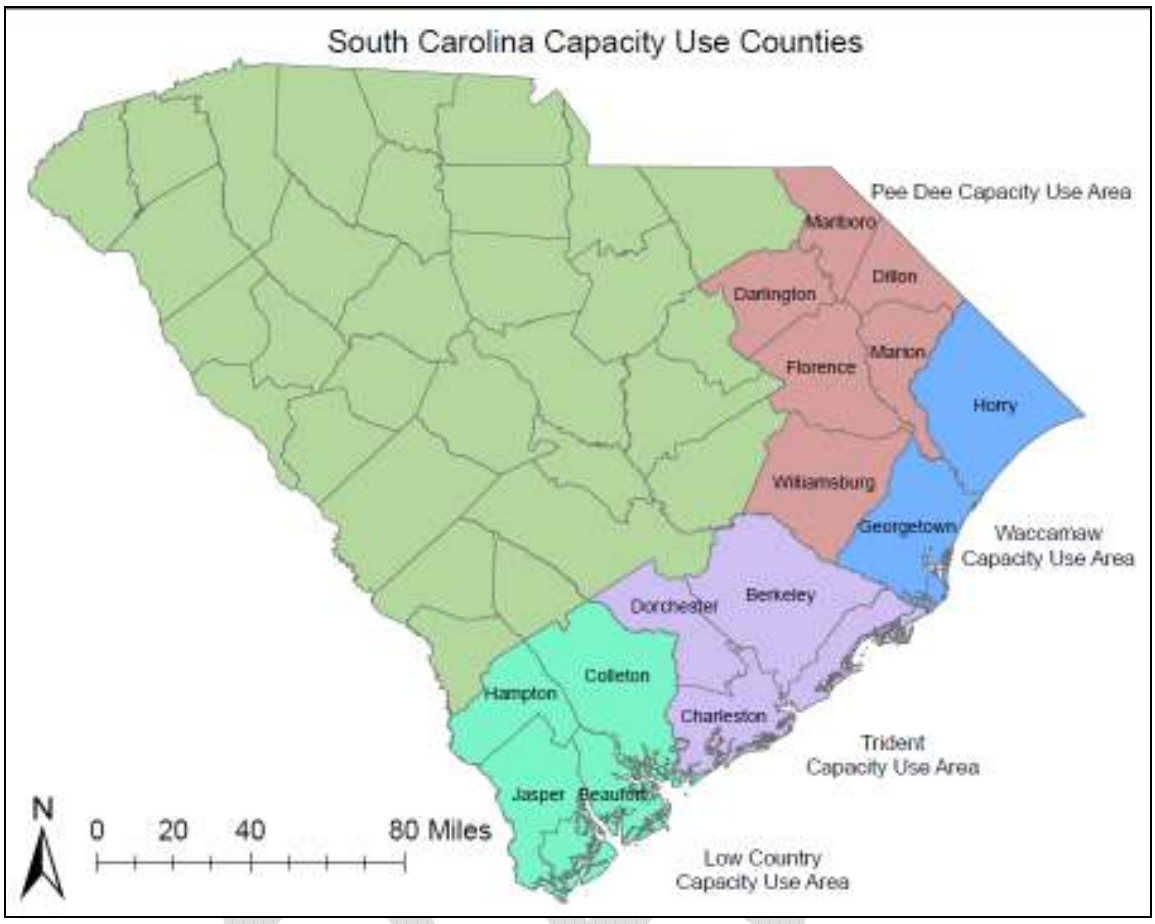


Figure 1. Capacity Use Areas.

Geo-Political Structure

As one of South Carolina's ten Regional Planning Councils, the BCDCOG's primary objectives include providing planning and technical support to local governments and assisting them in the development of local and regional plans. The BCDCOG is governed by a forty-five-member board, all of who are appointed by local governments within the three-county region. This board, led by an Executive Committee, sets policy and provides direction to the programs of the BCDCOG.

Currently, the three-county Trident area contains twenty-seven cities and towns and over half a million people. This includes a few central cities surrounded by smaller cities, island communities, and rural towns. Berkeley County's government is conducted through a Supervisor-Council form of government, while both Charleston and Dorchester Counties use Council-Administrator forms of government. The majority of the municipalities in the region utilize a Mayor-Council form of government.

In an effort to maintain continual assessment of the existing, or potential, need to distribute available groundwater capacity, as well as to recommend modification of the Groundwater Management Plan when necessary and provide recommendation to SCDHEC on permitting issues, the BCDCOG should maintain a standing Technical Advisory Committee to the BCDCOG Environmental Committee. This Committee will be appointed by the chairman of the BCDCOG and include representatives from utilities, industries, and environmental interest groups. This

committee may also include representatives of other organizations deemed to be appropriate by the chairman.

The SCDHEC has permit authority for all groundwater withdrawals in the Trident Area. Permits are issued after appropriate review in accordance with Chapter 5, The Groundwater Use and Reporting Act, Groundwater Use and Reporting Regulation, R.61-113, and the goals and management strategy developed in the Trident Area Groundwater Management Plan.

Regional Description

Comprised of Berkeley, Charleston, and Dorchester Counties, the Trident area covers 3,160 square miles, of which approximately 560 square miles are surface water. The Trident area stretches over seventy miles through central and southern South Carolina, bordered by the Edisto River on the south, the Santee River on the north, and the Atlantic Ocean on the east. The region extends some fifty miles inland towards the intersection of Interstates 26 and 95, and includes over ninety miles of Atlantic coastline. All three counties are located in the Coastal Plain physiographic region, Figure 2.

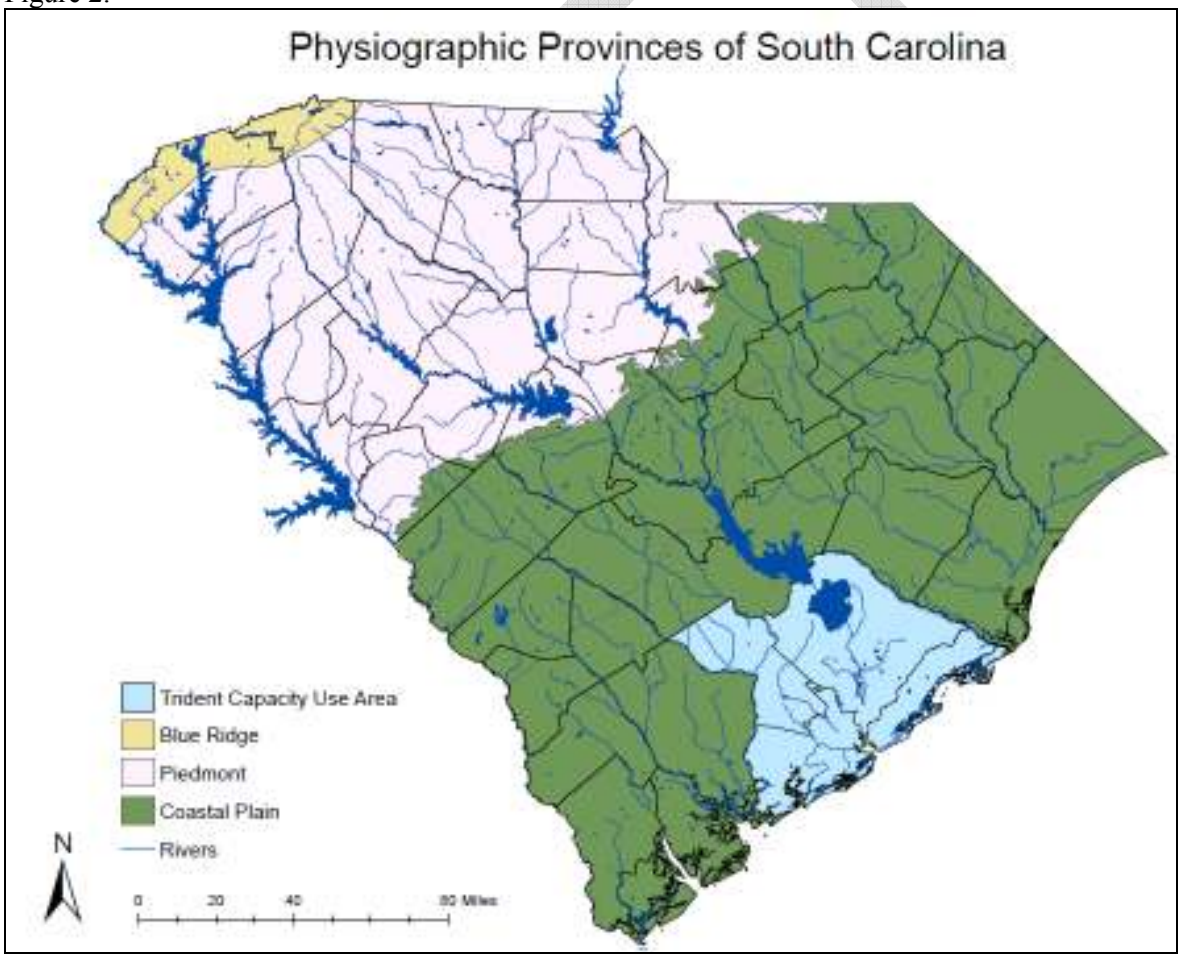


Figure 2. Physiographic Provinces of South Carolina.

There are several major water bodies in the area in addition to the Atlantic Ocean including Lakes Moultrie and Marion, numerous rivers such as the Ashley, Cooper and Wando Rivers and a network of streams, wetlands, and marshes, Figure 3. The topography of the region is very level with only slight undulations in the landscape. Elevations range from mean sea level to slightly over one hundred feet. Soil types vary from well-drained sandy loams to muck lands. Generally,

alluvial deposits border the larger streams, organic deposits underlie the swamps, and various types of loams cover the better-drained areas.

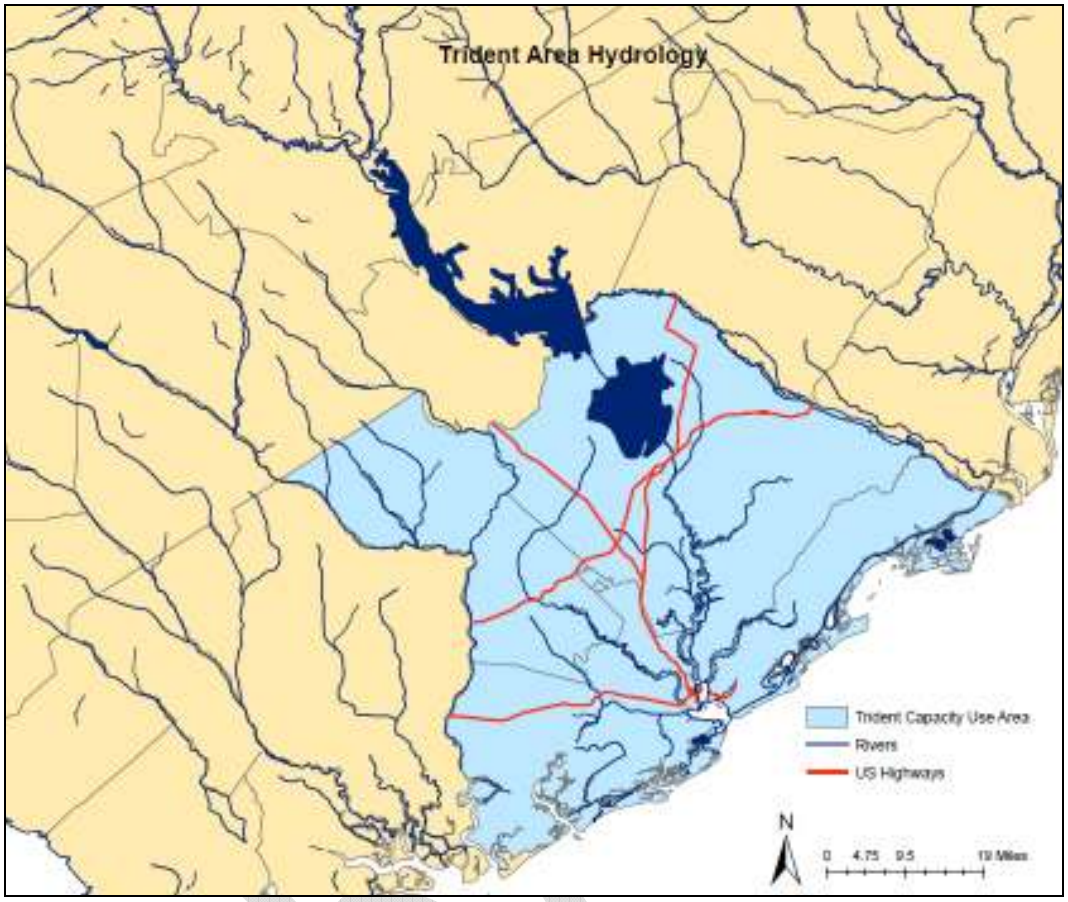


Figure 3. Hydrology of the area.

The Trident Area enjoys a relatively mild and moderate climate characteristic of its southeast US coastal location. Compared to overall State averages, winter temperatures are generally warmer and summers tend to be cooler and less humid. The average annual temperature is 65.6°F, with an average daily maximum of 75.5°F and a minimum of 55.7°F. Approximately forty-one percent of the forty-nine inches of average annual precipitation occurs during the summer months (Figure 4, 5). Thunderstorms are most frequent during the summer and create relatively short durations of concentrated runoff.

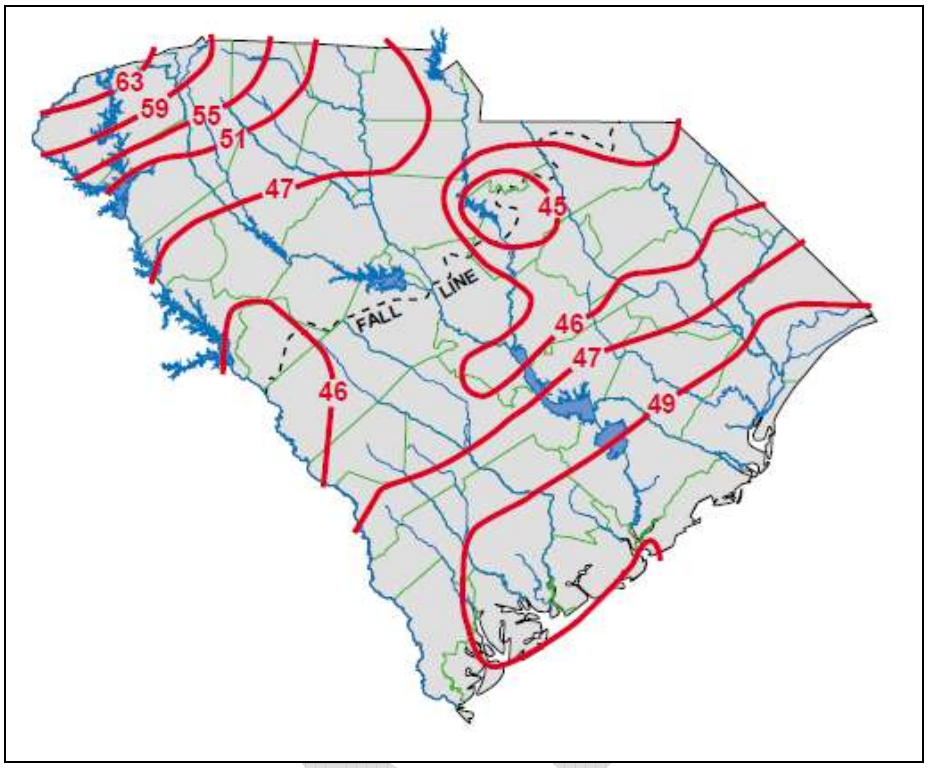


Figure 4. Average annual precipitation, in inches for the period 1948-1990.
Source: South Carolina Department of Natural Resources (SCDNR)-Hydrology/Geology Map 2, R.N. Cherry, A. W. Badr, and Andrew Wachob, 2001

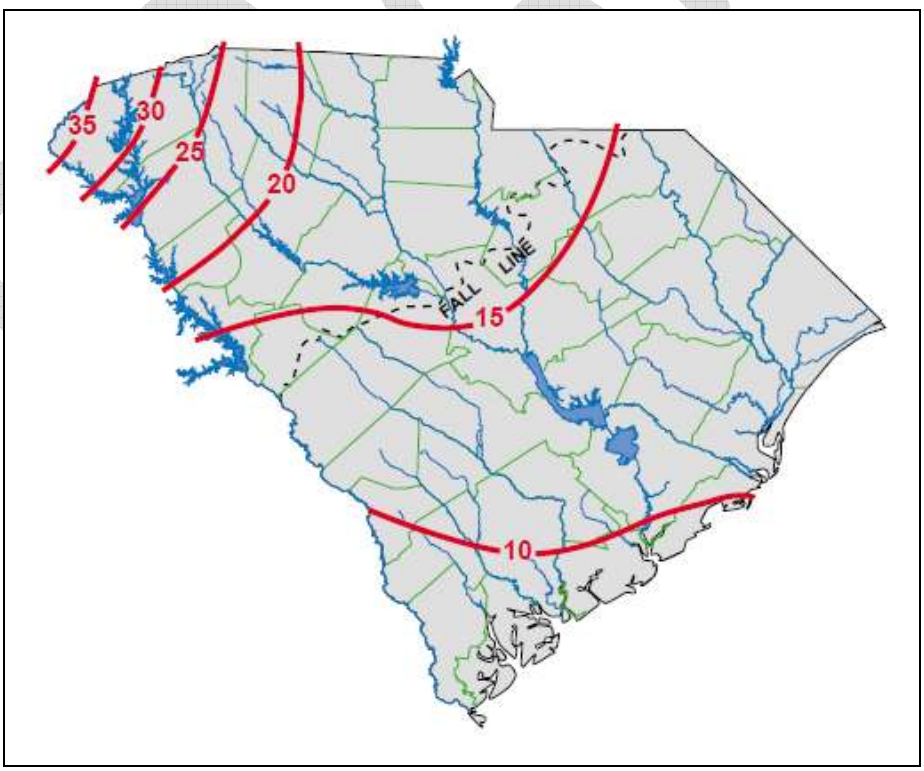


Figure 5. Average annual water yield (precipitation less evapotranspiration), in inches. 1948-1990.
Source: SCDNR-Hydrology/Geology Map 2, R.N. Cherry, A. W. Badr, and Andrew Wachob, 2001

Groundwater Supplies

The oldest (and deepest) aquifers or water-bearing units underlying the Trident Area are of Late Cretaceous age and comprise sediments that have been subdivided into four (4) aquifer systems (oldest to youngest): the Grambling, Charleston, McQueen Branch, Crouch Branch, and Gordan, Figure 6. These units are generally continental shelf to inner marine shelf and deltaic deposits and range from fine to medium grained sand, silts and clays. Water bearing zones typically are beds of sands of varying thickness and extent separated by silty, clayey beds or lenses.

- The Grambling Aquifer is not well defined and no known outcrop has been identified in South Carolina. It is thought to mainly consist of sand and gravel beds separated by thick layers of silt and clay.
- The Charleston/McQueen Branch Aquifer occurs throughout the Coastal Plain, from the Fall Line to the coast. The McQueen Branch crops out (catchment area) adjacent to the Fall Line from Chesterfield County to Edgefield County. In the Trident Area the aquifer is generally composed of thin- to thick-bedded sands and clays deposited in marginal marine and/or lower delta plain environments. In the Trident area, the McQueen Branch-Charleston aquifer is approximately 400 feet thick.
- The Crouch Branch Aquifer occurs throughout the Lower Coastal Plain and crops out in the eastern portion of the Coastal Plain from Lexington County to Dillon County. The aquifer is generally composed of thin- to thick-bedded sands and clays deposited in marginal marine and/or lower delta plain environments. In the Trident area, the Crouch Branch is approximately 400-800 feet thick.

Units overlying the Late Cretaceous formations include the Tertiary age Gordon, Floridan, and Surficial Formations, Figure 6. These units range from marginal marine to outer shelf deposits and their lithologies consist predominantly of sand, silt, and clay, with the upper part being mainly pure to impure limestone.

- The Gordon Aquifer extend from its catchment area in the middle of the Lower Coastal Plains southwest. In the Trident area, the Gordon is approximately 200 feet thick.
- The Floridan Aquifer occurs throughout the southern portion of the coastal plain. In the Trident area, the Floridan Aquifer is approximately 150 feet thick.
- The Tertiary units are overlain by a sequence of sand, silt, clay, and shells of Pleistocene age that are generally not more than fifty feet thick.

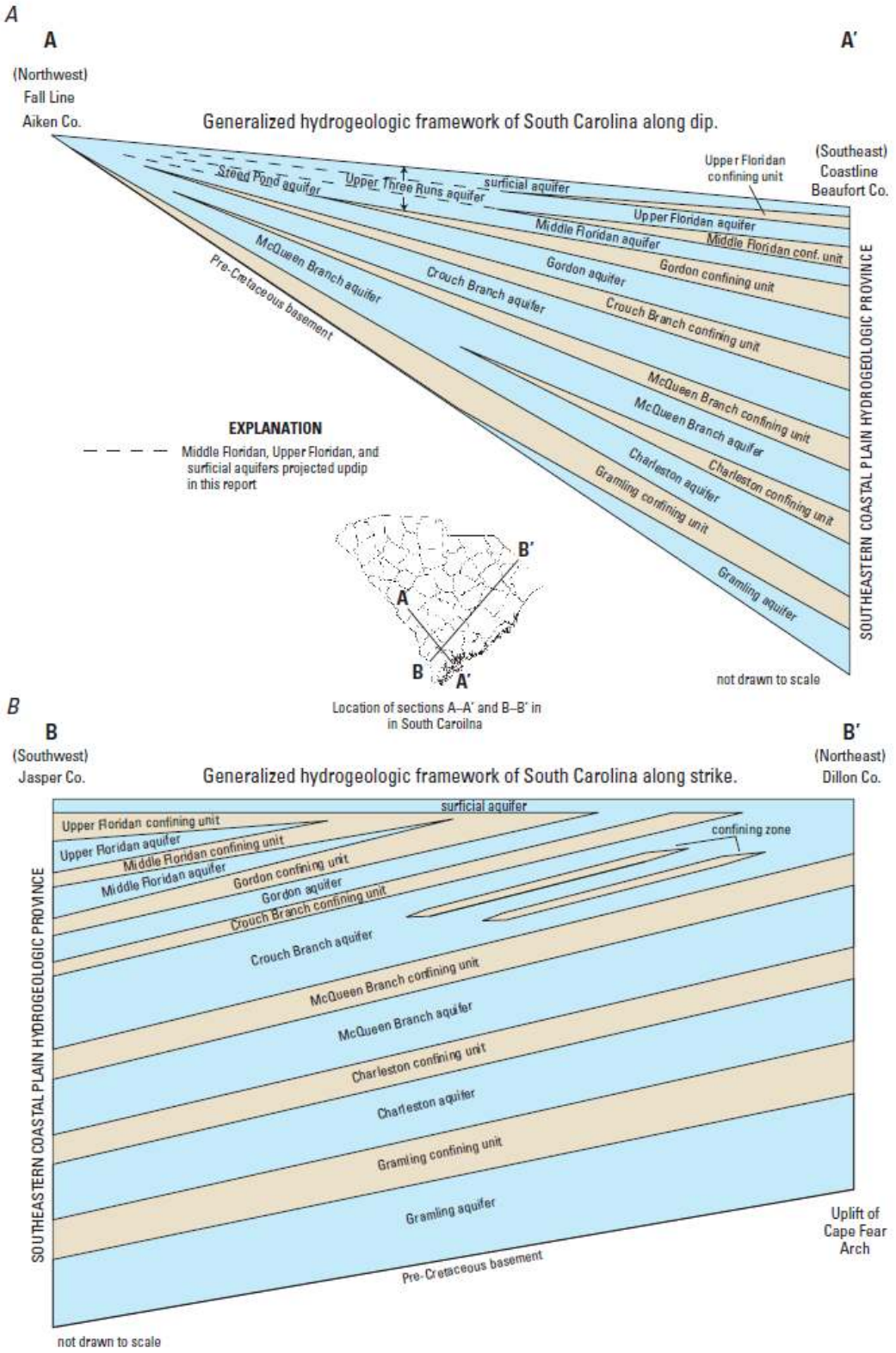


Figure 6. Generalized hydrogeologic framework. J. Gellici and J. Lautier, 2010 Hydrogeologic Framework of the Atlantic Coastal Plain, North and South Carolina: U.S. Geological Survey Professional Paper 1773, 113p.

Groundwater recharge occurs with infiltration of precipitation in catchment (recharge) areas. Figure 7 depicts the general recharge or catchment areas for the aquifers of the Trident Area. Although limited recharge of the Tertiary Sand/Limestone Aquifer occurs in the tri-county area, the majority of recharge of aquifers in the Trident area occurs mainly north of the region proper.

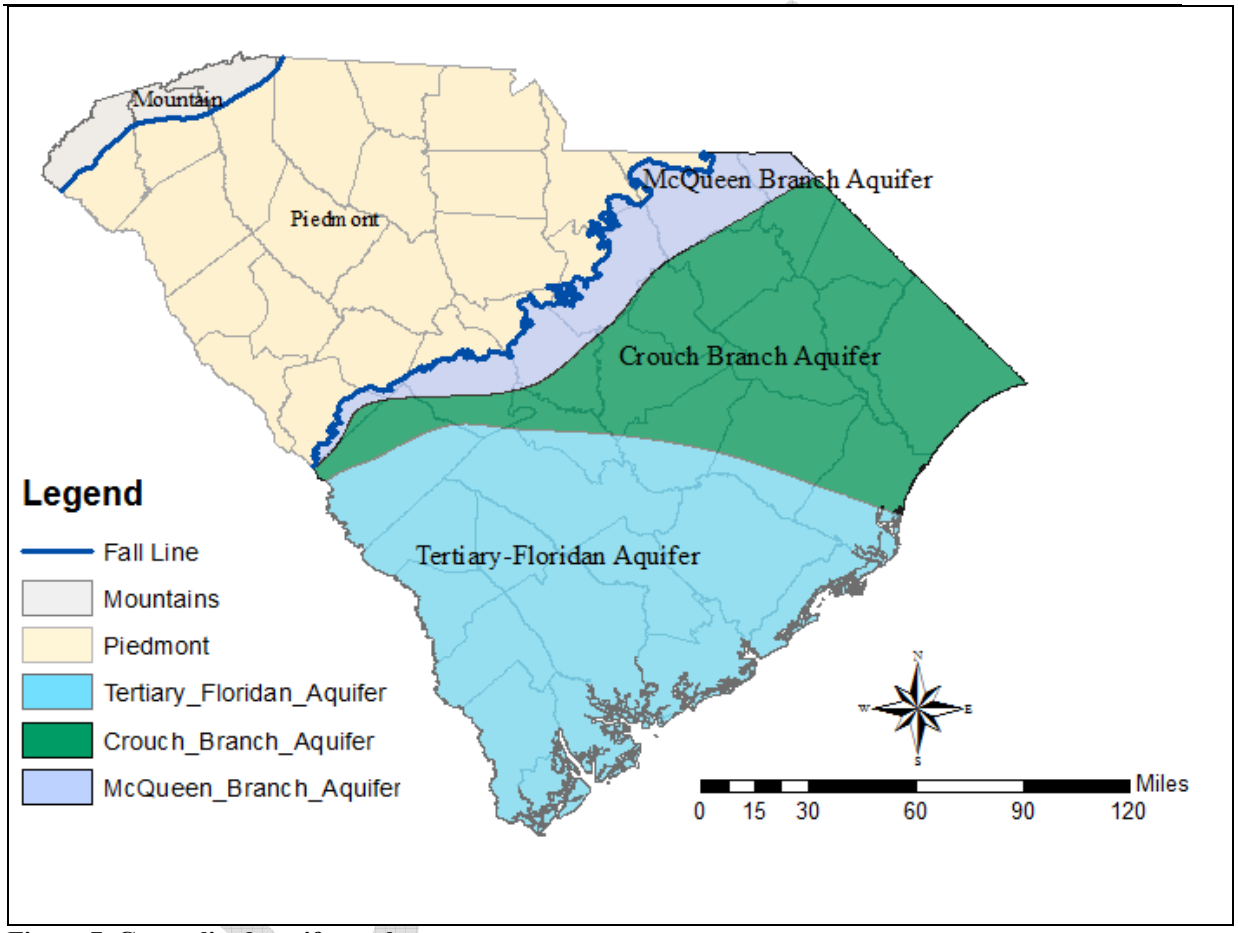


Figure 7. Generalized aquifer recharge areas.

Groundwater Levels Trends

Groundwater levels in the Charleston/McQueen Branch aquifer have declined substantially from pre-development (1879) levels in the Trident area. Much of this decline can be attributed to concentrated public supply and industrial usage. Prior to development, water levels in the Charleston/McQueen Branch aquifer in Charleston County were 126 feet above mean sea level. By 2000, the water level had dropped to 56 feet below mean sea level, a total decline of over 180 feet. Even with the increased use of surface water in the early 1990s, groundwater levels continued to decline. Interpretation of published hydrographs indicates that the rate of groundwater decline in

the Charleston/McQueen Branch Aquifer in Berkeley County was approximately 4 feet/year and in Charleston County was approximately 9 feet/year. Starting in 2006, public water supply systems in the area reduced their reliance on groundwater and increased their use of surface water. Between 2008 and 2016, the groundwater levels in the U.S. Geological Survey (USGS) observation well BRK-0431 rebounded by approximately 10 feet. Figure 8 shows the most recent potentiometric map for the McQueen Branch aquifer (formerly known as the Middendorf). In Mt. Pleasant, the groundwater levels have rebounded by as much as 50 feet based on potentiometric maps produced by the SCDNR (see Figure 9). As the population of the region increased over 63 percent between 1970 and 2000 and is projected to reach 806,000 by 2030 (Source: South Carolina Revenue and Fiscal Affairs Office, *http://abstract.sc.gov/chapter14/pop5.html*), demands on the groundwater resource are certain to increase in the future.

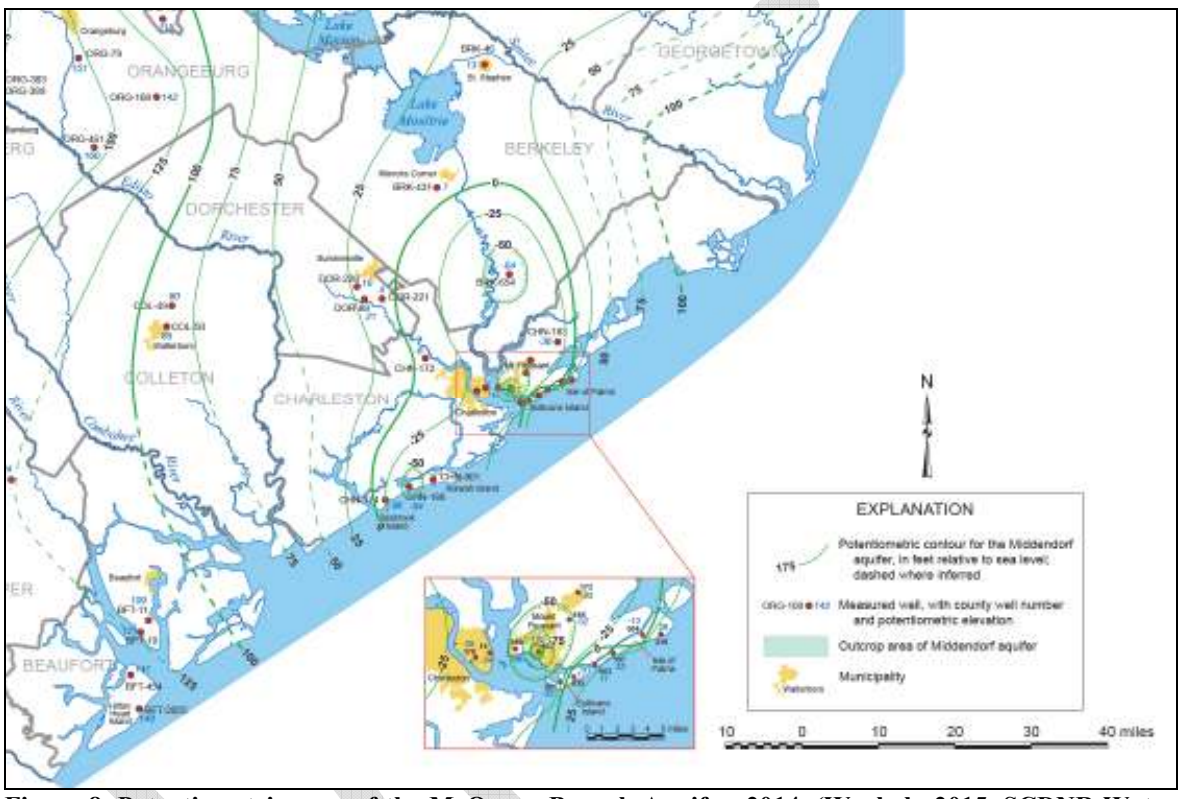


Figure 8. Potentiometric map of the McQueen Branch Aquifer, 2014. (Wachob, 2015, SCDNR Water Resources Report 58).

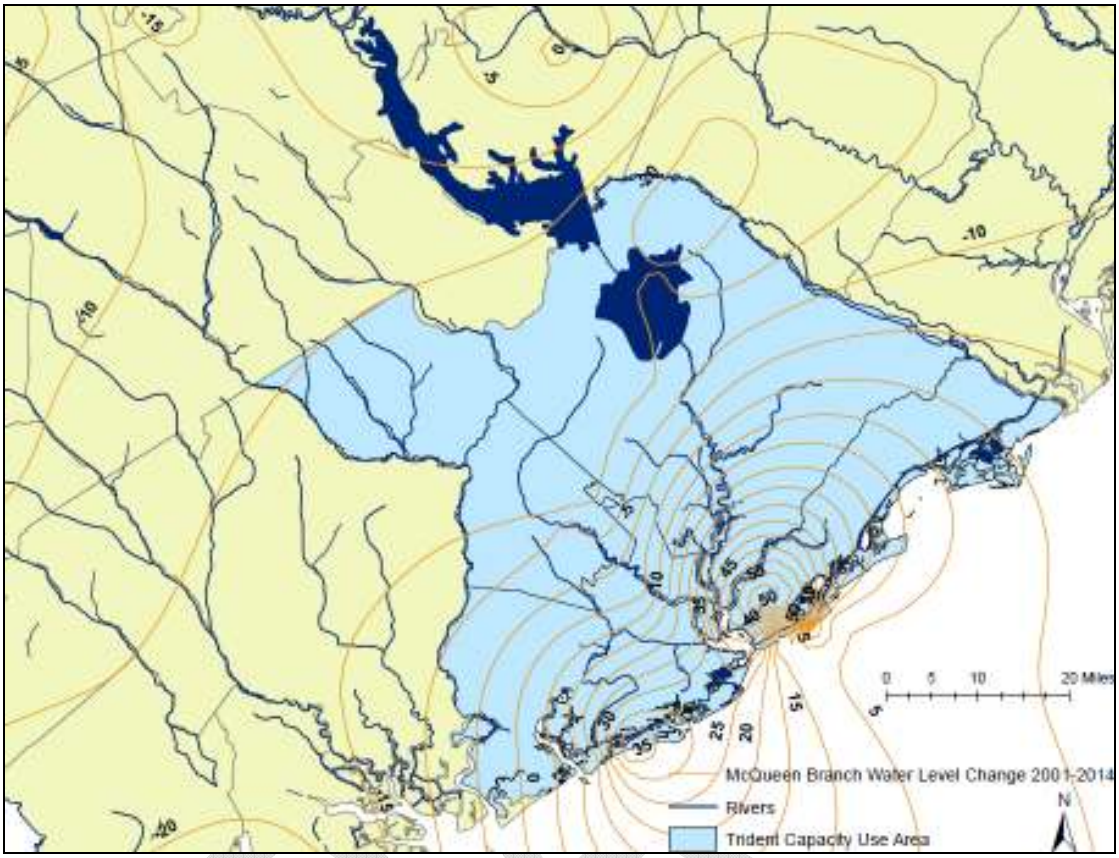


Figure 9. Water level difference in McQueen Branch Aquifer between 2001-2014 based on data from SCDNR Water Resources Report 28 (Hockensmith, 2003) and Water Resources Report 58 (Wachob, 2015).

Current Water Demand

For purposes of water use reporting, DHEC defines the following groundwater withdrawal categories:

- Aquaculture (AQ)– Water used for raising, farming and/or harvesting of organisms that live in water, such as fish, shrimp and other shellfish and vegetal matter (seaweed),
- Golf course irrigation (GC)- Water applied to maintain golf course turf, including tee boxes, fairways, putting greens, associated practice areas and periphery aesthetic landscaping,
- Industrial process (IN)- Water used for commercial and industrial purposes, including fabrication, processing, washing, in-plant conveyance and cooling,
- Agricultural and aesthetic irrigation (IR)- Water that is used for agricultural and landscaping purposes including turf farming and livestock management.
- Mining process (MI)- Water used in mine operations, including mining, processing, washing and cooling,
- Water supply (WS)- Water withdrawn by public and private water suppliers and conveyed to users or groups of users. Water suppliers provide water for a variety of uses including domestic, commercial, industrial and public water use.

Currently in the Trident Area there are 45 **permitted** groundwater withdrawers distributed as follows: 18 public water supply facilities, 12 golf course facilities, 11 industries, 3 agricultural irrigation facilities, and 1 thermal power facility. These 45 facilities have 113 wells, Figure 10.

Number of Facilities By Type and By County				
Category	Berkeley County	Charleston C county	Dorchester County	Totals
Golf Courses	1	10	1	12
Industry	5	3	3	11
Agricultural Irrigation			3	3
Thermal Power			1	1
Public Water Supply	4	4	10	18
Totals	10	17	18	45

Table 1 Permitted Groundwater Withdrawers by County

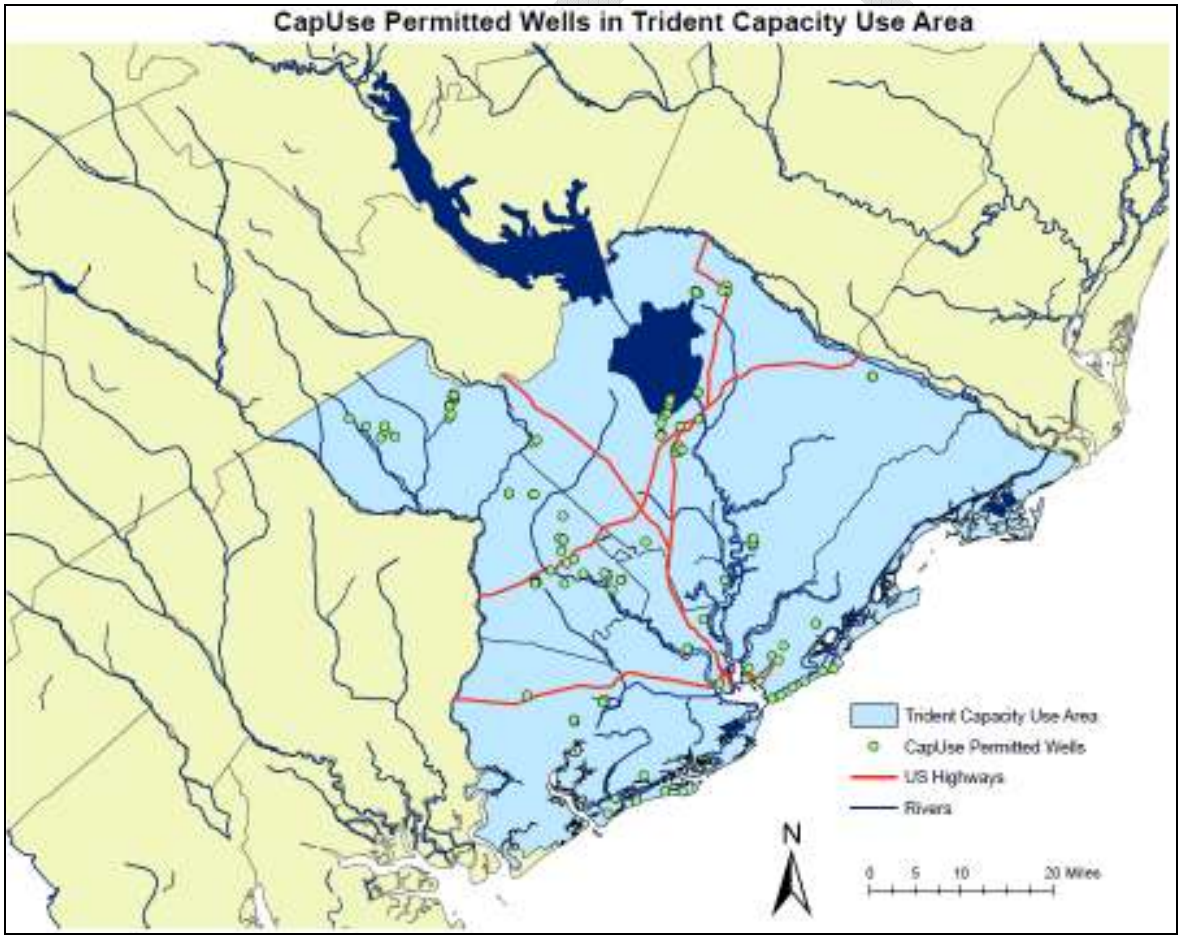


Figure 10. Location of Capacity Use Permitted Wells.

During the period 2010 through 2015, total reported groundwater withdrawals for the Trident Area averaged 4232.56 million gallons per year or approximately 11.56 million gallons per day (mgd). For Berkeley County, average withdrawals were: 10.83 million gallons for golf courses, 1,147.82 million gallons for industrial use, and 37.02 million gallons for public water supply. For Charleston County, average withdrawals were: 549.06 million gallons for golf courses, 60.15 million gallons for industrial use, and 1,438.88 million gallons for public water supply. For Dorchester County, average withdrawals were: 13.02 million gallons for golf courses, 388.6 million gallons for industrial use, 63.26 million gallons for agricultural irrigation, 100.41 million gallons for thermal power, and 459.75 million gallons for public water supply. For reporting year 2015, withdrawers in Berkeley County reported total withdrawals of 1,137,610,000 gallons (approximately 1.14 billion gallons), Charleston County 2,055,510,00 gallons (approximately 2.06 billion gallons), and Dorchester County 1,237,500,000 gallons (approximately 1.24 billion gallons). Reported usage by category for 2015 is listed in Table 2 and shown in Figure 11.

Table 2. Reported Use (Million Gallons) By County and Category For 2015					
Category	**Berkeley**	**Charleston**	**Dorchester**	**Totals By Category**	**Percent**
Golf Courses	3.66	412.38	13.40	429.44	9.61%
Industry	1092.44	53.01	399.28	1544.73	34.58%
Agricultural Irrigation			279.07	279.07	6.25%
Thermal Power			139.71	139.71	3.13%
Public Water Supply	41.515	1590.116	443.14	2074.77	46.44%
Totals For Counties	1137.61	2055.51	1274.60	4467.73	100.00%
Percent	**25.46%**	**46.01%**	**28.53%**	**100.00%**	

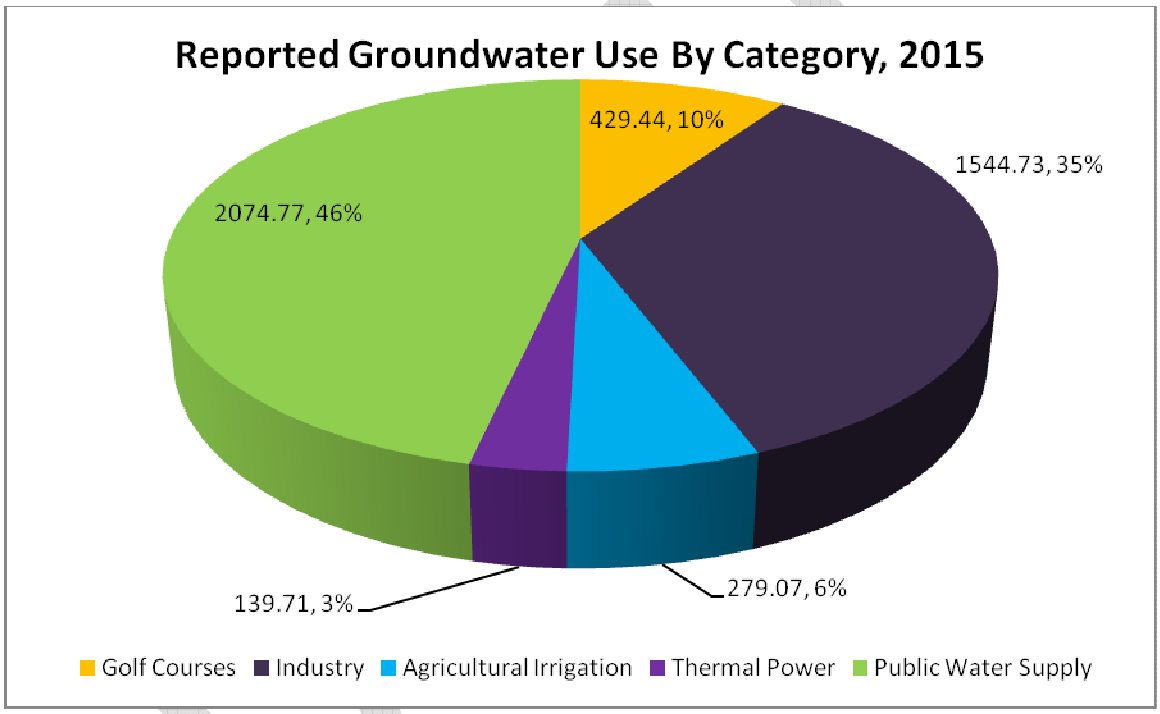


Figure 11. Reported groundwater use by category, 2015.

For the Trident Area in 2015, reported groundwater withdrawals from the Floridan aquifer were 2.75 million gallons, Floridan/Gordon aquifer were 278.49 million gallons, the Gordon aquifer 422.44 million gallons, the Gordon/Crouch Branch aquifer 102.94 million gallons, the Crouch Branch aquifer 602.38 million gallons, the Charleston aquifer 2943.45 million gallons and the Charleston/Grambling aquifer 78.03 million gallons. Groundwater withdrawals by aquifer/county are presented in Table 3 and Figures 12, 13, 14, and 15. In 2015 Charleston County used 46.39% of the region's groundwater while Dorchester County accounted for 27.93% of the use. Berkeley County used 25.68% of the total reported groundwater use for the Trident area in 2015.

Table 3. Reported Groundwater Use (Million Gallons) By Aquifer and County, 2015					
Aquifer	Berkeley County	Charleston County	Dorchester County	Totals	Percent
Floridan		2.75		2.75	0.06%
Floridan/Gordon	97.37	60.51	120.61	278.49	6.23%
Gordon	41.52	50.58	330.34	422.44	9.46%
Gordon/Crouch Branch			102.94	102.94	2.30%
Crouch Branch	0.16		639.48	639.64	14.32%
Charleston	998.572	1863.64	81.24	2943.45	65.88%
Charleston/Gramling		78.03		78.03	1.75%
Totals	**1137.61**	**2055.51**	**1274.61**	**4467.73**	**100.00%**
Percent	**25.46%**	**46.01%**	**28.53%**	**100.00%**	

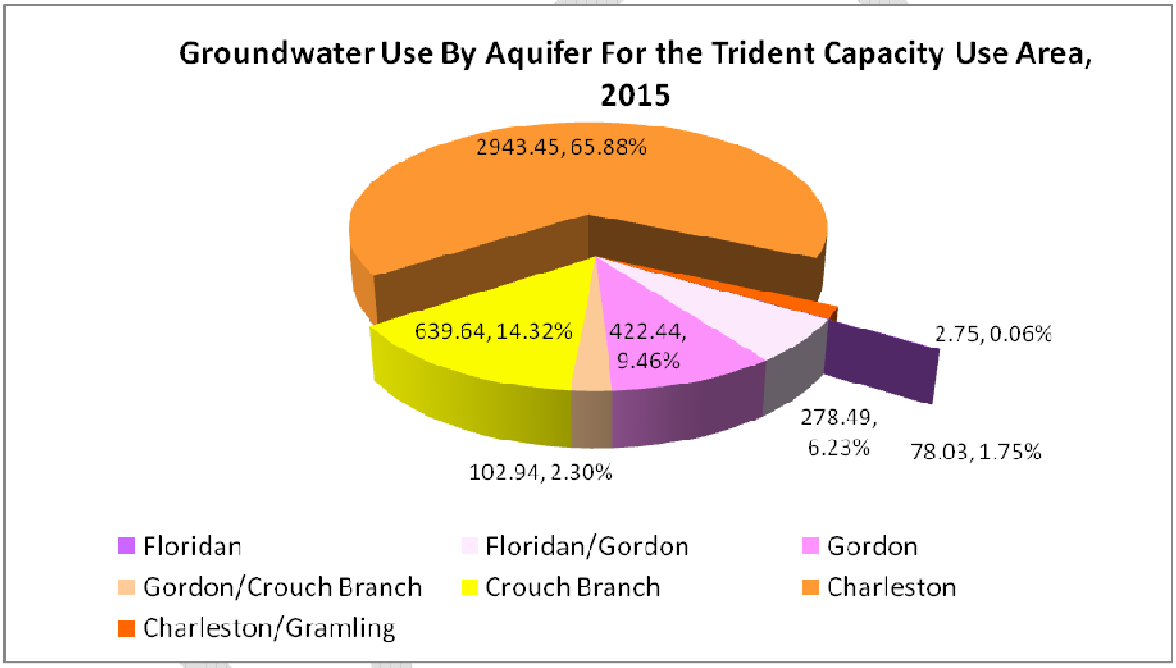


Figure 12. Reported groundwater use by aquifer, 2015.

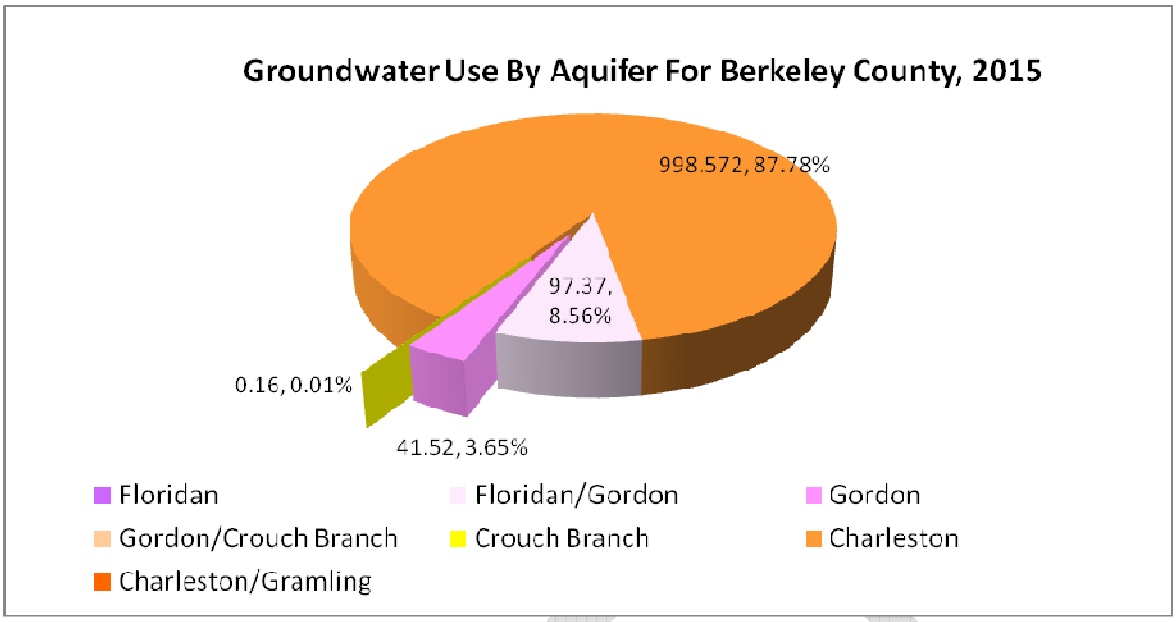


Figure 13. Reported groundwater use by aquifer for Berkeley County, 2015.

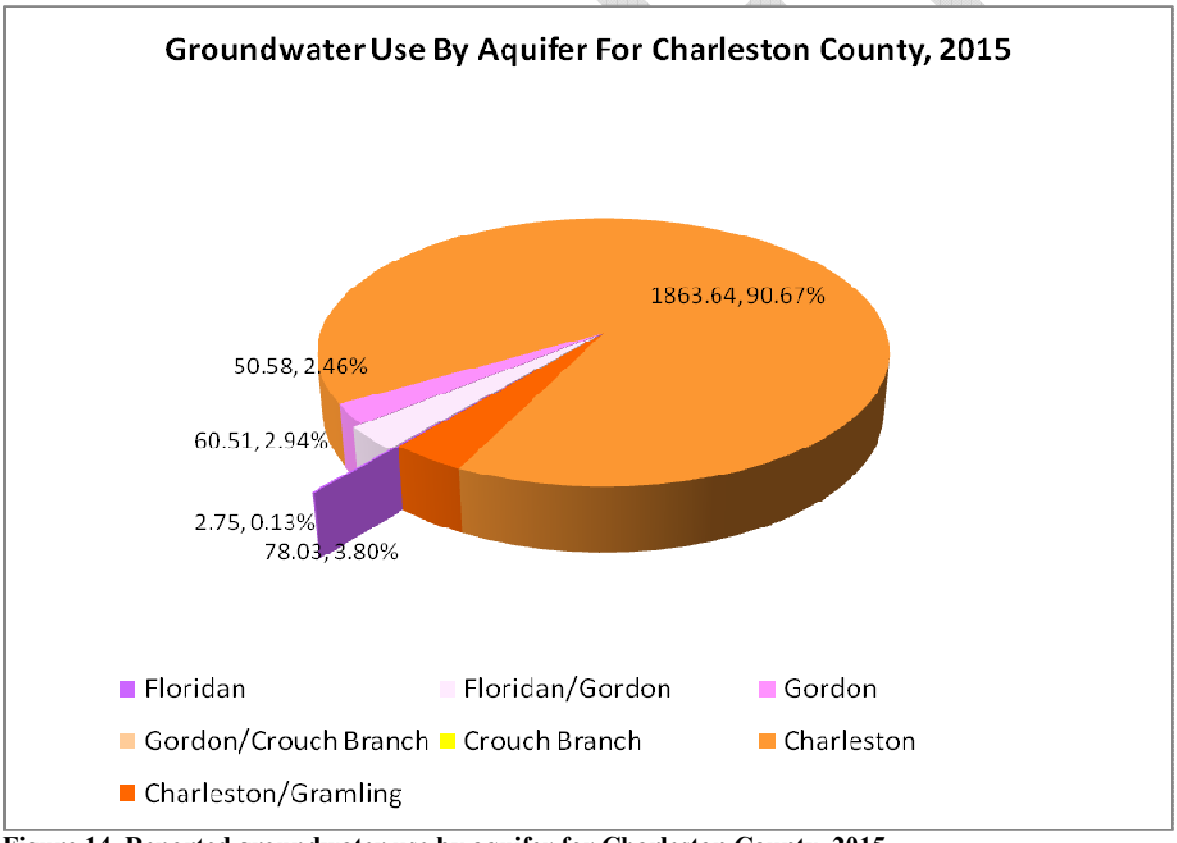


Figure 14. Reported groundwater use by aquifer for Charleston County, 2015.

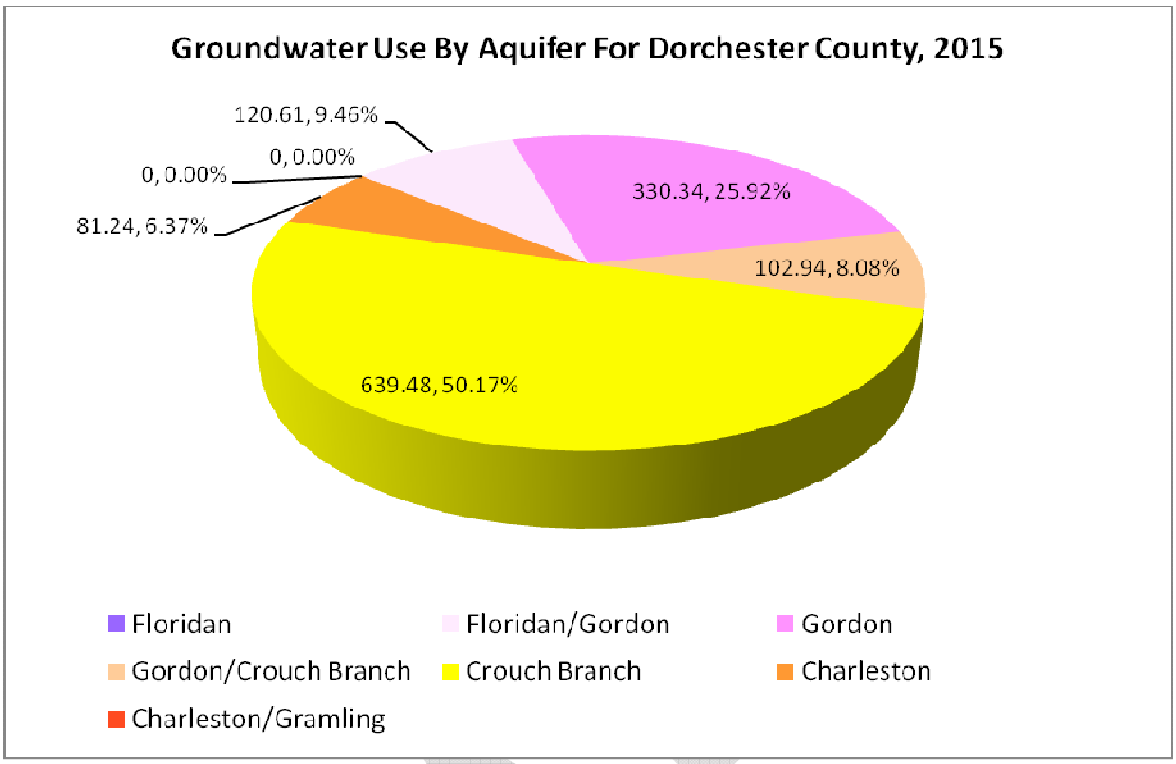


Figure 15. Reported groundwater use by aquifer for Dorchester County, 2015.

Population, Growth, and Water Use Projections

As with coastal communities around the nation, the population in the Trident area has increased dramatically, rising over 46.8 percent the last 30 years. At the time of the 2010 Census, over 660,000 people were living in the region. Since the 2000 Census, Dorchester County experienced the largest percent increase in population, followed by Berkeley and Charleston Counties, as shown in Table 4.

County	April 1, 2000 Census	April 1, 2010 Census	Change in Population	Percent Change
Berkeley	142,651	177,843	35,192	24.7%
Charleston	309,969	350,209	40,240	13.0%
Dorchester	96,413	136,555	40,142	41.6%

Table 4 County Population Change 2000-2010, ***Source: http://abstract.sc.gov/chapter14/pop5.html, SC Statistical Abstract, Table 5, Status of Population Projections Based on the 2010 Census Data, South Carolina Revenue and Fiscal Affairs Office*****)**

Table 5 depicts population projections for the three counties and the region as a whole from 2000 to 2030 presented in the *South Carolina Statistical Abstract, 2010,* as prepared by the South Carolina Revenue and Fiscal Affairs Office. The region is expected to grow by more than 256,967 people between 2000 and 2030, an increase of 46.8 percent. While Charleston County has the highest population (360,600 in 2015) and is projected to continue to have a higher population than the other three counties, Dorchester County is projected to experience the largest percent increase in population, followed by Berkeley County.

Population Counts and Projections 2000-2030								
County	April 1, 2000 Census	April 1, 2010 Census	July 1, 2015 Projection	July 1, 2020 Projection	July 1, 2025 Projection	July 1, 2030 Projection	Projected Change	Projected Percent Change
Berkeley	142,651	177,843	187,800	197,700	208,400	219,100	76,449	53.6%
Charleston	309,969	350,209	360,600	370,900	383,800	396,700	86,731	28.0%
Dorchester	96,413	136,555	152,000	167,400	178,800	190,200	93,787	97.3%
Trident Area	549,033	664,607	700,400	736,000	771,000	806,000	256,967	46.8%

Table 5 County Projected Population Change 2000-2030, ***Source: http://abstract.sc.gov/chapter14/pop5.html, SC Statistical Abstract, Table 5, Status of Population Projections Based on the 2010 Census Data, South Carolina Revenue and Fiscal Affairs Office*****)**

Permitted withdrawal limits in the Trident Area total 13,592.5 million gallons per year. Total reported usage for 2015 in the Trident Area was 4,453.68 million gallons (Table 6).

Berkeley County			Charleston County			Dorchester County		
Facility Permit	Permit Limit *	Reported Use* 2015	Facility Permit	Permit Limit*	Reported Use* 2015	Facility Permit	Permit Limit*	Reported Use* 2015
08GC001	24.00	3.66	10GC002	175.00	52.40	18GC004	27.00	13.40
08IN002	60.00	31.89	10GC003	36.00	10.25	18IN001	385.00	238.53
08IN004	132.00	12.56	10GC010	97.00	1.15	18IN002	190.00	65.60
08IN007	103.00	78.28	10GC012	36.00	14.54	18IN040	250.00	95.15
08IN011	1300.00	969.71	10GC015	100.00	74.39	18IR002	36.00	30.12
08IN015	182.50	0.00	10GC016	50.00	11.89	18IR003	235.00	182.7
08WS003	288.00	6.63	10GC020	113.00	112.43	18IR004	98.00	29.15
08WS058	1750.00	0.00	10GC021	350.00	78.03	18PT001	198.00	139.71
08WS064	50.00	34.88	10GC052	140.00	24.05	18WS001	1210.00	11.04
08WS066	36.00		10GC053	50.00	33.25	18WS002	164.00	121.05
Totals	**3925.50**	**1137.61**	10IN004	42.00	0.00	18WS003	36.00	29.20
			10IN010	64.00	53.01	18WS005	650.00	192.20
			10IN011	54.00		18WS006	15.00	6.20
			10WS003	258.00	81.23	18WS007	60.00	0.00
			10WS006	3953.00	1413.05	18WS008	175.00	3.04
			10WS007	108.00	2.44	18WS011	97.00	79.75
			10WS010	200.00	93.40	18WS014	15.00	0.67
			Totals	**5826.00**	**2055.51**	**Totals**	**3841.00**	**1237.51**

*Limits and use reported in million gallons

Table 6 Permit limits versus reported usage (all in Millions of Gallons)

Potential future groundwater demands are estimated for water supply, based on population projections, and all other categories (total) based on an estimated nominal growth of 2.5% per year.

Water Supply:

For 2015 in the Trident Area, total groundwater withdrawal for water supply is approximately 2,074,770,000 gallons . Combined with reported surface water supply (36,709,600,000 gallons), the per capita use of water in the Trident Area is approximately 106 gallons per day. Utilizing this value (106 gpd), projected population, and assuming groundwater will represent approximately 5% of the total water supply demand, groundwater demand is projected through 2030 (Table 7).

2015	2020	2025	2030
2,074.77 MGY	2,180.23 MGY	2,283.91 MGY	2,387.59 MGY
5.68 MGD	5.973 MGD	6.26 MGD	6.54 MGD

Table 7 Projected Groundwater Demand-Water Supply (millions of gallons) in Trident Area

Other:

Groundwater demand for all other categories through 2030 is calculated based on an estimated nominal and steady growth of 2.5% per year (Table 8).

2015	2020	2025	2030
2,355.85 MGY	2650.34 MGY	2981.63 MGY	23354.34MGY
6.45 MGD	7.261 MGD	8.17 MGD	9.19 MGD

Table 8 Projected Groundwater Demand-Other (millions of gallons) in Trident Area

Total Projected Water Demand:

Total potential groundwater demand for the Trident Area is estimated from the calculations for Water Supply (Table 7) and Other category (Table 8) (see Table 9).

	2015	2020	2025	2030
Water Supply	2074.77	2180.23	2283.91	2387.59
Other	2355.86	2650.34	2981.63	3354.34
Total MGY	4430.63	4830.57	5265.54	5741.93
Total Mgal/day	12.14	13.23	14.43	15.73

Table 9 Total Projected Groundwater Demand-Trident Area (million gallons)

Groundwater Management Strategy

The ultimate goal of the Groundwater Management Plan is to outline a process to conserve and protect the groundwater resource while establishing conditions that are conducive to the continued development and long-term viability of the aquifers of the Trident Area. In short, the goal is to develop and implement a sustainable development strategy. Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their needs. Ultimately, good scientific data must be available that allow the sustainable yields from each aquifer system in the Trident Area to be determined, and permits for withdrawals issued accordingly. However, these data do not fully exist at this date. This plan, therefore, must focus on obtaining this critical data and the issuance of permits for reasonable water withdrawals in the interim. The key strategies to achieve these goals are outlined below.

Strategy #1: Identify areas where a leveling and/or reduction in pumping is appropriate.

Prior to each permit renewal cycle, SCDHEC will consider the best available information on the geologic and hydrogeologic characteristics of the aquifer(s) and groundwater withdrawals of the area to protect against or abate unreasonable, or potentially unreasonable, adverse affects on the aquifer(s) and water users of the Trident Area. Measures that the SCDHEC may require applicants, permit holders and groundwater withdrawers to take may include, but not be limited to, the following:

- Reduction of groundwater withdrawal in areas of concentrated pumping;
- Withdrawals from other available freshwater aquifers than those currently used;
- Selective curtailment or reduction of groundwater withdrawals where it is found to be in the public interest or general welfare or to protect the water resource;

- Conjunctive use of aquifers, or waters of less desirable quality, where water quality of a specific character is not essential;
- Construction and use of observation or monitor wells;
- Abandonment of wells that have penetrated zones of undesirable water quality where such wells are found to cause contamination of freshwater aquifers;
- Prohibiting the hydraulic connection of aquifers that could result in deterioration of water quality in a freshwater aquifer(s);
- Abandonment of wells, which will be filled with cement grout, plugged, and sealed;
- Implement reasonable and practical methods to conserve and protect the water resources and to avoid or minimize adverse effects of the quantity and quality of water available to persons whose water supply has been materially reduced or impaired as a result of groundwater withdrawals;
- Such other necessary and appropriate control or abatement techniques as are technically feasible.

As an example, a cone of depression in the McQueen Branch/Charleston aquifer developed in the Charleston/Mt. Pleasant area between the 1980's and early 2000's. Water-levels in the USGS well CHN-0014 (Figure 16.) declined approximately 90 feet in the McQueen Branch/Charleston aquifer. In 2006, public water supply systems reduced their use of groundwater by increasing their reliance on surface water (Figure 17.). Groundwater use for public water supply was reported at 3,248.9 million gallons in 2005; by 2015 the amount reported used had declined to 2,104.7 million gallons. Surface water use for public water supply increased from 32,973.2 million gallons in 2005 to 36,709.6 million gallons. This has resulted in a rebound of groundwater levels in the area of approximately 50 feet.

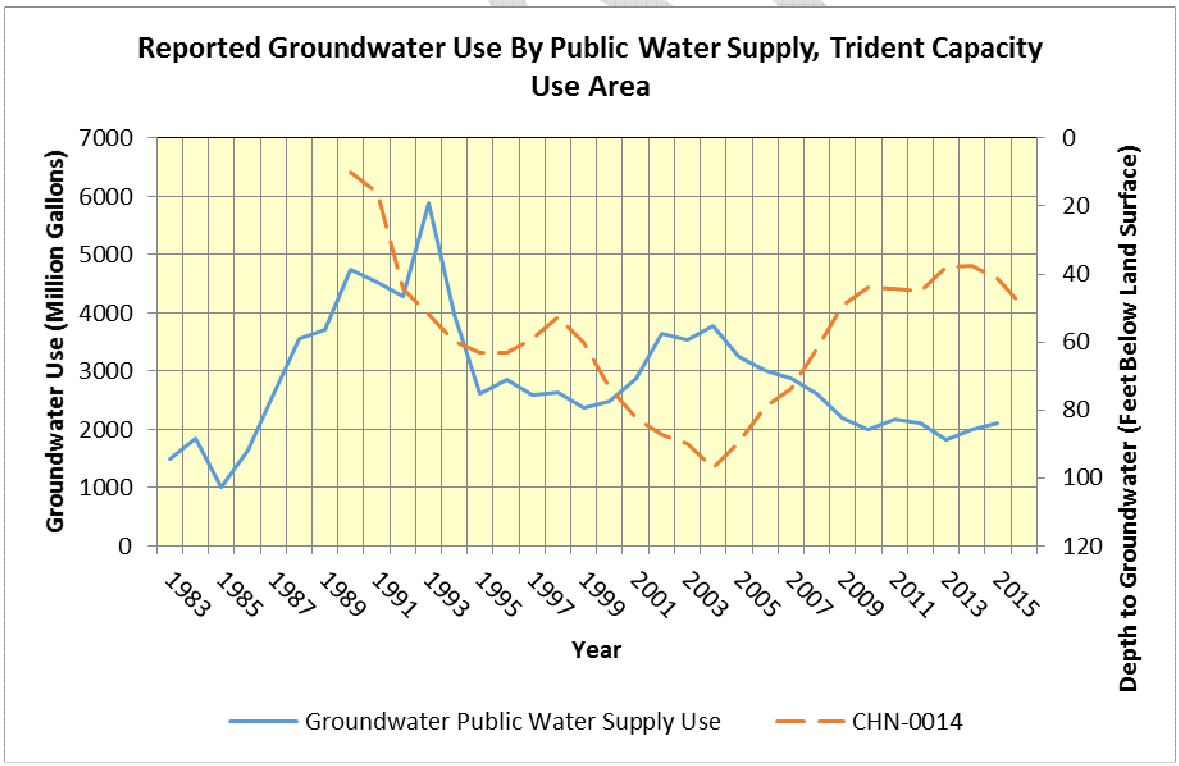


Figure 16. Comparison of water use to groundwater levels in the McQueen Branch aquifer.

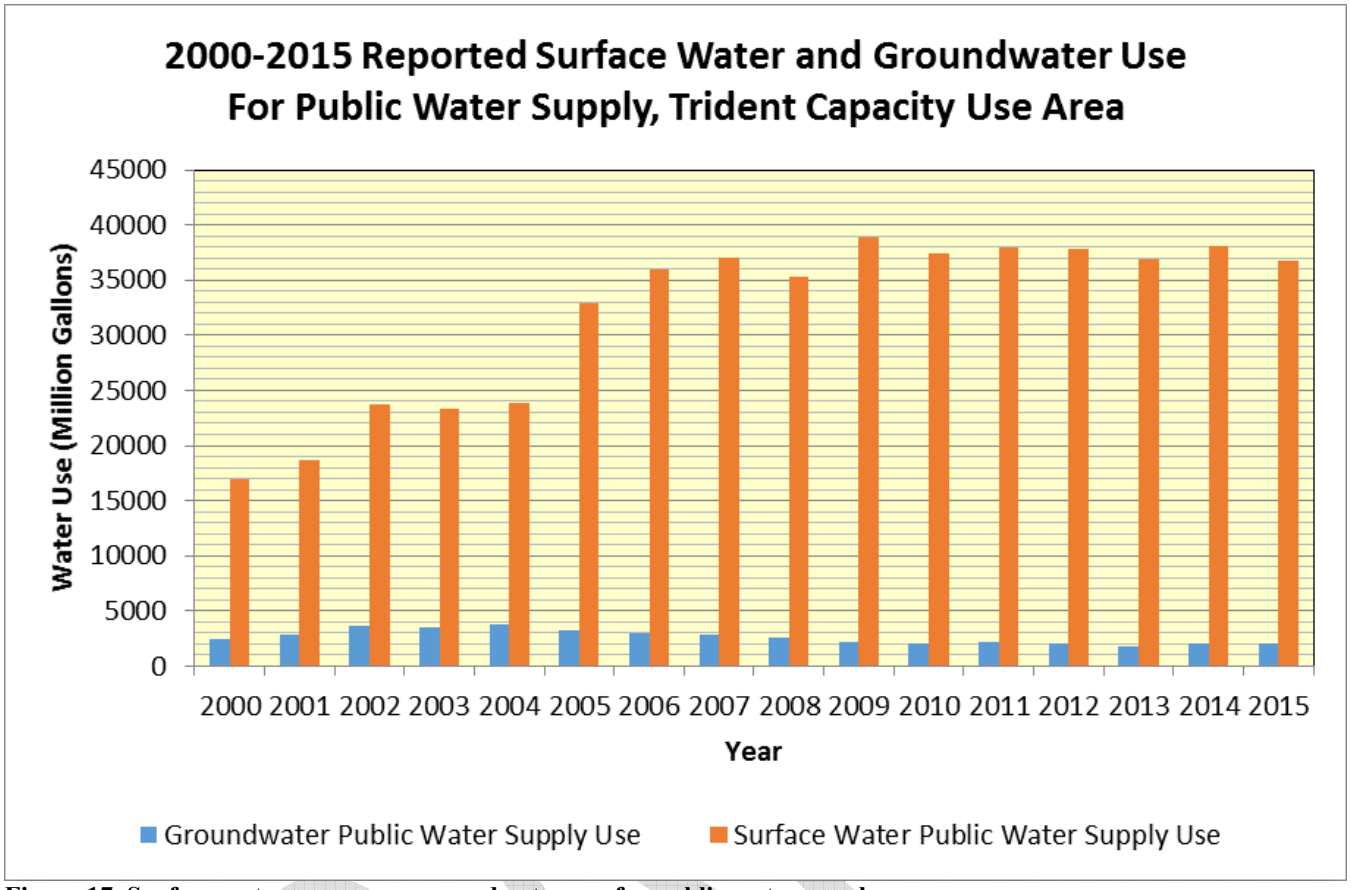


Figure 17. Surface water use versus groundwater use for public water supply.

The reduction in the reliance on groundwater versus surface water for public water supply required the coordination and cooperation of the utilities in the area and is a prime example of users working together to protect and manage the groundwater resource.

Strategy #2: Review of permit applications based on demonstrated reasonable use.

Proposed withdrawals will be evaluated considering reasonableness of use and need, aquifer(s) being utilized, potential adverse effects on adjacent groundwater withdrawers, previous reported water use, anticipated demand for the proposed activities, availability of alternate water sources and reported water use at facilities with similar activities. Applications for groundwater withdrawal will incorporate a "Water Use Plan" or a "Best Management Strategy" detailing actual or proposed water use activities and all conservation techniques for site specific water management including, but not limited, to:

- Provide appropriate documentation that the proposed water use is a beneficial use of the resource and necessary to meet the reasonable needs of the applicant;
- Describe in detail the applications for which the water is being withdrawn and approximate quantities utilized in each application;
- Identify the aquifer(s) currently utilized and the hydrogeologic (groundwater quality, specific capacity/yield, etc.) factors for utilization. Identify if a less utilized aquifer is suitable to the facility's need;
- Identify additional or alternate sources of water, including surface water, effluent, or recycled water, among others, suitable to meet the needs of the applicant and supplement, minimize, or eliminate groundwater sources;

- Identify reasonable and appropriate conservation methods or practices that maximize current water use and reduce current water demand;
- Identify any existing or anticipated adverse effects on other groundwater withdrawers, including public use, and strategies to eliminate or minimize these effects.

Strategy #3: Establish a comprehensive groundwater monitoring program.

With increased population and a growing industrial base, water demand is increasing at an expanding rate. Although water level declines are a normal response to groundwater withdrawals, not stabilizing these declines may cause serious impairment to the aquifers and groundwater quality of the region. SCDHEC will pursue partnerships with local entities, groundwater users and other agencies (both Federal and State) to facilitate the most effective use of resources in designing and maintaining a monitoring network for the Trident Area. Both the USGS (Southeast Region) and the SCDNR maintain several groundwater level monitoring locations in the Trident area. The table below lists the wells currently being used to monitor groundwater levels in the Trident Capacity Use Area.

County	Well Id	Aquifer	Agency
Berkeley	BRK-0644	Floridan	SCDNR
Berkeley	BRK-0431	McQueen Branch	USGS
Charleston	CHN-0014	McQueen Branch	USGS
Charleston	CHN-0044	Floridan	SCDNR
Charleston	CHN-0101	Floridan	SCDNR
Charleston	CHN-0484	Floridan	SCDNR
Chalreston	CHN-0803	Floridan	SCDNR

Current needs for additional groundwater level monitoring locations (Figure 18.) include a well cluster in northern Berkeley County (1 Crouch Branch well and 1 McQueen Branch/Charleston well) at the SCDNR location BRK-0644, a well cluster in central Berkeley County at the current BRK-0431 USGS well (1 Floridan and 1 Crouch Branch well), a well cluster at the current CHN-0014 USGS well (1 Floridan and 1 Crouch Branch well), and a well cluster in Dorchester County (1 Floridan well, 1 Crouch Branch Well and 1 McQueen Branch/Charleston well).

Expanding the current network will allow more accurate monitoring of groundwater level conditions and facilitate scientifically-based recommendations for strategies to address any stressed conditions identified in the aquifers used in the Trident area.

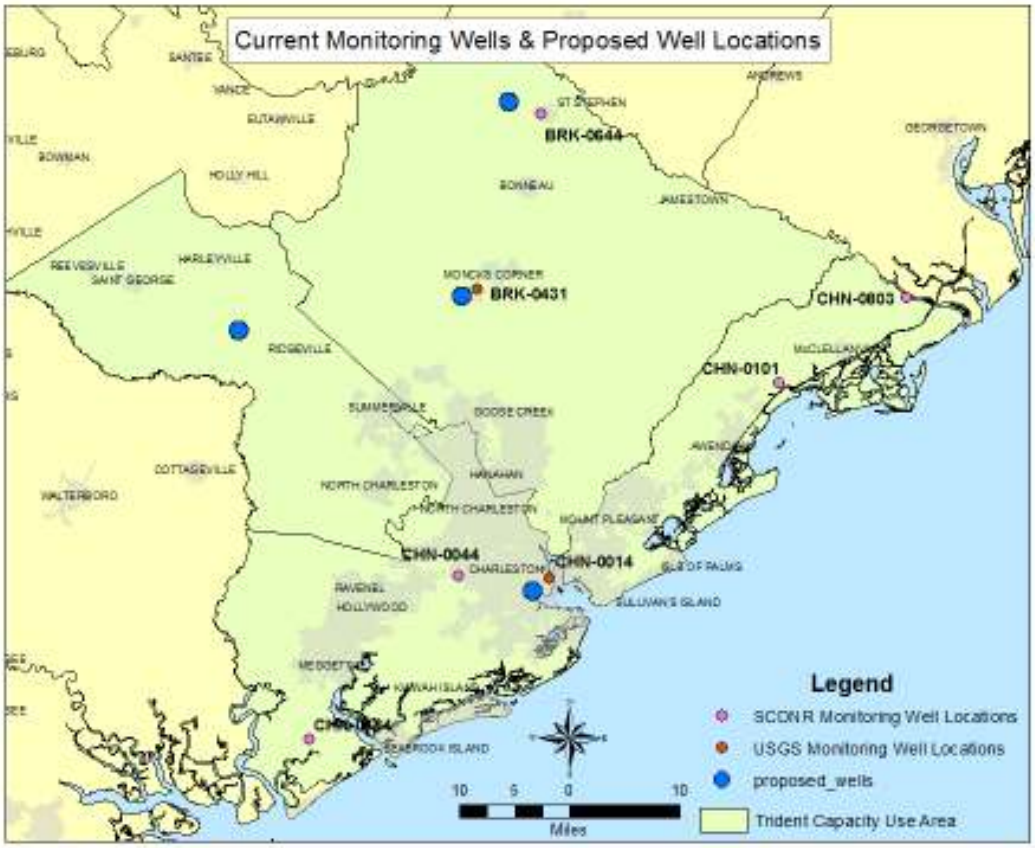


Figure 18. Locations for potential additional monitoring wells.

The existing groundwater monitoring network with the additional locations is necessary to:

- Provide accurate data on the amount and rate of groundwater level declines;
- Establish the correlation between groundwater pumping and water level changes, both on a local and regional scale;
- Guide management efforts to minimize potential impairment of the aquifers and track progress in reversing water level declines;
- Provide groundwater withdrawers with timely and accurate information to effectively manage withdrawal activities.

Strategy #4: Establish a conservation educational plan for the general public and existing groundwater withdrawers.

Water conservation has increasingly become a cornerstone to the development of water management strategies. An effective, viable water conservation program should incorporate the following:

- Provide public education and outreach programs;
- Determine and enhance water use efficiency;
- Determine water losses and establish corrective actions;
- Prepare for water shortages and provide appropriate responses.

Strategy #5: Regulation and Planning.

The Groundwater Use and Reporting Act provides for regulation of water withdrawals in South Carolina. Groundwater regulation is necessary to protect and provide for the long-term sustainability of the resource. As data are developed on the groundwater resources of the designated Capacity Use Areas, the regulations should will be reviewed to ensure that sufficient and adequate protection of the resource is provided.

SCDNR is responsible for developing and updating the State Water Plan. A groundwater model of the coastal aquifers is currently being developed by the USGS and SCDNR. As the results of the modeling effort and the updates to the State Water Plan become available, they will help inform potential regulatory and policy changes and will be incorporated into this Groundwater Management Plan.

Groundwater Management Plan Reports

Every 5 years, or length of the permitting cycle, total annual groundwater withdrawals will be compiled and compared to available aquifer potentiometric maps. The report will include the following information:

- Listing of all permitted withdrawers, permitted withdrawal limits, and average groundwater withdrawal;
- Evaluation of withdrawal by category and by aquifer;
- Identification of areas of aquifer stress and all withdrawers utilizing the stressed aquifer(s).

Based on the information developed for the plan report, modifications of groundwater withdrawals in stressed areas will be reviewed and subsequently the Groundwater Management Plan may be amended. The report will also evaluate, as information is developed, changes in water quality of the aquifers, available storage capacity of the aquifers, project future rates of withdrawal and estimate future groundwater declines from the projected withdrawal rates. Through time, a safe sustainable yield for each aquifer will be developed and subsequent withdrawal limits will be based on this available yield.